MISSISSIPPIAN DISCONFORMITY AND COMPACTION

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One of the best examples of a disconformity in Ohio is displayed in a railroad cut about one-half mile northeast of Marshallville in Chippewa Township. This disconformity has been mentioned by Conrey.[1] The outcrop shows a horizontal mass of Mississippian sandstone of the Waverly series, and above it and dipping away from it on all sides, the lower portion of the Pottsville formation of the Pennsylvanian system. What formation of the Waverly series is represented in the exposure has not been satisfactorily determined. It is probably the Logan sandstone formation. It is believed by some geologists that the member may be the Black Hand sandstone of the Cuyahoga formation. The thick-bedded sandstone with occasional thin beds of shale resembles to some degree the Black Hand sandstone in its northerly extension in Ohio.

The Pottsville formation in the exposures near Marshallville consists of rather coarse-grained sandstone with occasional small white quartz pebbles from one-eighth to one-half inch in diameter. It is not as conglomeratic as is usual of the basal Pottsville. The jointing is irregular and varies in color from gray to yellow to red. It contains the carbonaceous remains of plants. The basal sandstone grades upward into coal-black laminated shales containing concretions. In this shale are occasional sandy strata. Glacial till covers the entire area.

As one walks along the railroad in a northeasterly direction from Marshallville, the first buried hill makes its appearance. Here the massive sandstone beds of the Waverly are flanked for the most part by shale and some sandstone strata which dip away in all directions, at first steeply and diminishing with distance. Farther on, the basal beds of the Pottsville rise to form an arch which appears above the track level in the cut. The buried hill of Waverly sandstone is not exposed but the evidence of its existence is indicated by the dome-like structure of the basal Pottsville. Farther on, the railroad cuts across the top of the largest of the buried sandstone hills (Figs. 1 and 2). The Pottsville beds dip away in all directions, first steeply and gradually flattening out with distance and ultimately becoming horizontal.

Before the advent of the glaciers in Pleistocene time, the Pennsylvanian formations were eroded from the top of the buried hills but were preserved in the basins between.

In the long interval which elapsed after the Mississippian beds were laid down a great amount of erosion must have taken place. Over a large part of Ohio, the upper Mississippian was completely removed and in the northeastern part of the state, a large part of the Waverly series of lower Mississippian age was eroded. In some places in northeastern Ohio, so much of the Waverly series was eroded that the basal Pottsville beds lie not far above the Berea sandstone. Throughout Ohio and beyond there is evidence of widespread erosion following the Mississippian and prior to the deposition of the Pennsylvanian formations.

A study of the exposures near Marshallville indicates that the Mississippian sandstone was weathered during the interval represented by the disconformity. Incorporated in the beds at the base of the Pottsville formation are sandstone fragments derived from the Waverly sandstone. These are angular for the most part but show the effects of having been moved by waves and currents. The

[1]Conrey, G. W., Geology of Wayne County, Geological Survey of Ohio, Bulletin 24, 1924, page 92.

contact between the Pottsville and Waverly is sharp. The basal Pottsville shales and sandstone flatten out where they project over the top of the buried hill.

It is evident that a rough topography resulted from the erosion of the Mississippian formations before the advent of the Pottsville sea. A hilly topography was invaded by an encroaching Pennsylvanian sea. That the hills were buried beneath Pennsylvanian sediments and not removed by wave and current erosion may indicate that the land sank at such a rate that marine erosion did not have time to bevel the surface.

FIG. 1. A buried hill composed of horizontally lying Waverly sandstone and the inclined, overlapping Pottsville strata. Note the decrease in dip of the Pottsville beds from the hill.

The irregularity of the contact between the Mississippian and Pennsylvanian systems can be appreciated when the variation in elevation of the contact is obtained over large areas. In places, differences of more than 150 feet or more occur within short distances. At one locality in Wayne County the contact is 1060 feet above sea level and five and one-half miles to the southwest the conglomerate in the Pottsville formation at the base of the Pennsylvanian rests on

the Waverly surface at an elevation of 880 feet above tide. Many other striking illustrations of the magnitude of this unconformity in Ohio could be given. As the Pennsylvanian seas covered the rough Waverly surface, the oldest members of the Pennsylvanian system were deposited in basins and channels.

According to Twenhofel,[2] deformation caused by compaction results from the settling of sediments over any rigid body. This may be a buried hill, a reef or a sand or gravel lens. Compaction arises from the expulsion of water, closer packing or new combinations of sediments. It is believed to be negligible in sands and

FIG. 2. Section of the Waverly sandstone. The entire width of the exposure in the railroad cut is about 300 feet.

coarser clastics and is most important in fine-grained sediments such as clays, silts and calcareous muds. Some marls and clays are composed of as much as 70% water and many fine-grained sediments contain more than 50%. Much of this water is expelled with a corresponding reduction in volume. Compaction due to

[2]Twenhofel, W. H., Principles of Sedimentation, pp. 532–533.

crystallization and packing is also noteworthy. However, the expulsion of water is by far the most important factor. Fine-grained sediments deposited over and around reefs and lenses of sand or coarse clastics may experience compaction of 50% or more. Strata passing over the non-compactible Waverly sandstone hills would become arched into domes and anticlines, depending on the slopes of the buried features.

The fine-grained sediments would be washed from the high places into the basins. There can be subaqueous sliding from the steeper slopes into the basins. Twenhofel points out that compaction and settling proceed simultaneously with deposition, maintaining some slope until the high places have been completely buried and the overlying formations could be warped through considerable thicknesses. The buried hill or rigid body could thus be reflected through considerable thicknesses of sediment as folds or domes.

The buried Waverly surface with its hills would be favorable for the development of structures of compaction origin. They have been noted in the mid-continent and other regions in the drilling for oil. The marked dip of the Pottsville beds in all directions from the buried hills and the dome and anticlinal structure above them may be accounted for by compaction.